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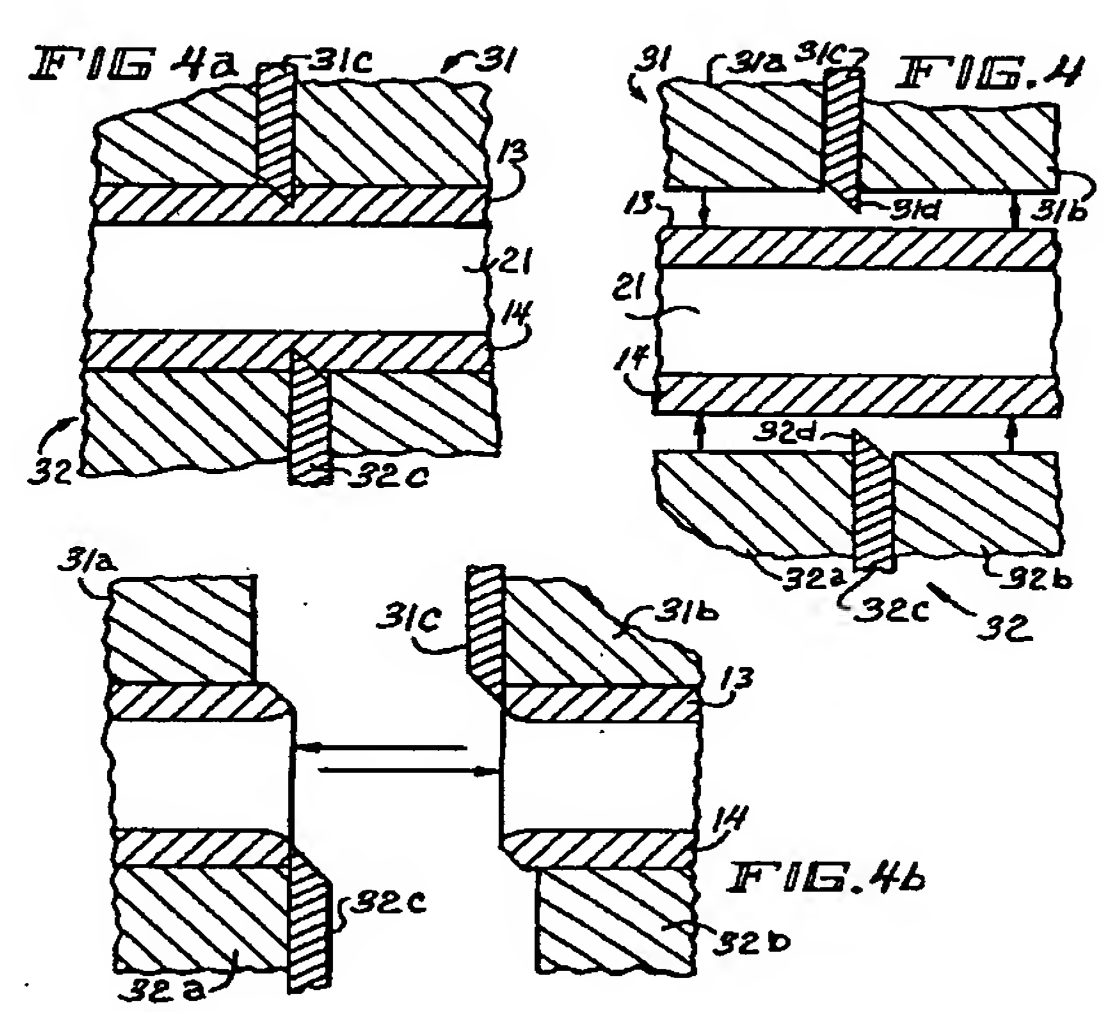
(54) Method and apparatus for separating thin-walled, multiport micro-extrusions.

(57) A method for separating a thin-walled multiport extrusion into a plurality of micro-tubes (10) for use as single pass lengths in a heat exchanger assembly, the method including the steps of threading the micro-extrusion into a clamping device including first (31) and second (32) sets of clamping blocks which hold the micro-extrusion rigidly while the clamping blocks of the clamping device are drawn in opposite directions on opposite sides of a groove cut (42) in the upper (13) and lower (14) walls of the extrusion, tearing the extrusion apart along cutting lines formed in the upper and lower walls of the extrusion during the separation process.



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Background of the Invention

The present invention relates to heat exchanger assemblies, and more particularly to a method and apparatus for separating sections of thin-walled multiport micro-extrusions to provide micro-tubes for use in heat exchanger assemblies.

In order to produce heat exchanger assemblies that are of extremely high efficiency, lightweight and economical, heat exchanger assemblies are being produced which employ a thin-walled multiport condenser tube. The small condenser tube, hereinafter referred to as a micro-tube, is a very small oval tube approximately one-half inch to one inch in width and .050 inches to .100 inches in thickness and having a multitude of minute ports, typically ten to twenty in number within the tube. The condenser tube is formed using an extrusion process which provides a micro-extrusion typically a hundred feet or more in length. The micro-extrusion is cut into sections of usable length, typically twenty to thirty inches long. A plurality of such micro-tubes are assembled together with a suitable heat transfer array such as, for example, folded fin units, which are positioned between parallel passes of the micro-tubes. Such heat exchanger assemblies provide a condenser of extremely high efficiency while being extremely lightweight and economical in the use of material.

The use of the micro-tubes as a condenser tube in a heat exchanger assembly has mandated that the micro-tube be made as an extrusion, preferably of aluminum. In such an extrusion, preferably of aluminum, the micro-tub with its minute ports is produced from a solid billet and the ports are formed from solid material. In the extrusion process, the inside of the micro-tube and its ports are completely devoid of any contamination.

Known arrangements for providing such micro-tubes in the desired pass lengths involves the use of saw cutting to cut extruded lengths of thin-walled multiport tubing to the desired lengths. A major problem with such separation method is that metal cuttings, or particles, and cutting lubricants penetrate the openings, or ports in the tubing, plugging the openings. Because of the microscopic size of the individual ports, it is an extremely difficult task to remove such contamination from the ports. Due to the end use of the product, namely a refrigeration condenser or heat exchanger, it is essential that no foreign matter enter the heat exchanger during its fabrication.

It would therefore be highly desirable to have a method and apparatus for parting extruded, extremely thin-walled multiport micro-tubes into single predetermined lengths, without the use of saws to cut tubular stock to sections of the desired lengths, cutting lubricants, or other conventional means which require breaching the ports during the separation process.

Summary of the Invention

It is therefore a primary object of the present invention to provide a method and apparatus for parting micro-extrusions of extremely thin-walled, multiport heat exchanging tubing without closing or restricting the ports or openings and without introducing foreign matter into the ports.

A method in accordance with the present invention includes threading or positioning of the micro-tube stock into a clamping device which holds the micro-tube rigidly during the operation of the clamping device and which sizes the height dimension of the tubing. The clamping means is then moved laterally in opposite directions, drawing the micro-tube apart along a cutting line formed in the upper and lower surfaces of the micro-tube. The cutting line may be formed either by the clamping means or by separate scoring means. Depending on the wall thicknesses involved and the port wall thicknesses, the lateral movement of the clamping means is less than about .25 inches. Due to the pull apart feature and the elongation characteristics of the present invention, the metal in the uncut or unscored wall and port walls tends to neck down into a bell mouth shape, which shape is highly advantageous in aiding the flow of liquid or gases from the manifold into or out of the micro-tube with minimal pressure drop. Also, the integrity of the inside of the micro-tube is maintained without restriction to flow. Moreover, the cleanliness and noncontamination of the inside of the micro-tube is maintained during the cleavage operation.

The invention consists of certain novel features and structural details hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the details may be made without departing from the spirit, or sacrificing any of the advantages of the present invention.

Description of the Drawings

For the purpose of facilitating and understanding the invention, there is illustrated in the accompanying drawings a preferred embodiment thereof, from an inspection of which, when considered in connection with the following description, the invention, its construction and operation, and many of its advantages will be readily understood and appreciated.

FIG. 1 is a top plan view of a thin-walled multiport micro-tube for use in a heat exchanger assembly;

FIG. 2 is a side elevational view of the micro-tube illustrated in FIG. 1;

FIG. 3 is an enlarged end view of the micro-tube illustrated in FIG. 1, showing the ports which extend through the micro-tube;

FIG. 4 is a simplified representation of apparatus for separating a micro-extrusion into sections to

provide a plurality of micro-tubes for use as pass portions in a heat exchanger assembly;

FIGS. 4a and 4b illustrate steps in the method of separating the micro-extrusion into sections using the apparatus illustrated in FIG. 4;

FIG. 5 is a sectional view of a webbing micro-tube which defines the ports through the micro-tube;

FIG. 5a illustrates the webbing during the separation process illustrating the necking down of the micro-tube to form a bell mouth shape in accordance with the present invention;

FIG. 5b illustrates the section of the webbing separated in accordance with the present invention; and

FIGS. 6, 6a, 6b and 6c illustrate steps in another method of separating a micro-extrusion into sections of micro-tube for a heat exchanger assembly in accordance with the present invention.

Description of Preferred Embodiment

Referring now to the drawings wherein like numerals have been used throughout the several views to designate the same or similar parts in FIGS. 1-3, there is illustrated a thin-walled, multi-port micro-tube 10 for use in a heat transfer assembly. The micro-tube 10 consists of an oval tube approximately one-half to one inch in width and .050 inches to .100 inches in thickness. The micro-tube 10 has a first end 11 and a second end 12, a top wall 13 and a bottom wall 14 and side walls 15 and 16. The micro-tube includes a plurality of minute ports or channels 20 which extend substantially in a parallel spaced relation between the ends 11 and 12 of the micro-tube 10. The ports 20 are defined by a plurality of webs 21 which extend, preferably diagonally, between the upper wall 13 and lower wall 14 of the micro-tube 10. The micro-tube 10 is extruded with its minute ports 20 from a solid billet and the ports 20 are formed from solid material. In the extrusion process the inside of the tube and the ports are formed, with the inside of the tubing being devoid of any contamination. The micro-tube is, preferably, made of aluminum because of its heat transfer characteristics. The aluminum metal is extruded into extremely long lengths and, using the methods and apparatus in accordance with the present invention, is separated or parted into single path lengths, typically ten inches to thirty inches without the use of cutting procedures that breach the ports and without the use of cutting lubricants or other foreign matter which could get into the ports or channels 20 during the separation procedure.

Referring now to FIG. 4, in accordance with one method for separating a multiport micro-extrusion into sections to produce micro-tube lengths of ten inches to thirty inches, for example, a length of micro-extrusion is threaded into a clamping device including an upper clamping assembly 31 and a lower clamping assembly 32. The clamping device holds the extrusion rigidly during the separating operation and at the same time sizes the very critical height dimension of the micro-tube. The two clamping assemblies 31 and 32 are approximately twice the length of the tube pass desired, i.e., the length of the micro-tube 10. Both the clamping assemblies 31 and 32 are split at the center to define two block 31a and 31b, for assembly 31, and blocks 32a and 32b, for assembly 32. One of the block portions 31b has a knife blade 31c rigidly attached at the center of the block 31b with its knife edge 31d set at a depth of cut to penetrate the upper surface 13 of the tube 10 to about 60% of its thickness of the top wall of the tubing 10. The knife edge 31d is flat on one side and has a 45° angle on the opposite side of the blade. In practice, the depth of cut and the angle of sharpening of the blade can be slightly varied.

Similarly, the bottom clamping device 32 on the diagonally opposite side from the above clamping device 31 has a knife blade 32c carried by block 32a with its edge 32d being flat on one side and cut to 45° on the opposite side of the blade. Blade 32c is also set to penetrate the bottom wall 14 of the tube 10 to approximately 60% of its thickness. The blades 31c and 32c are set approximately opposed to each other with the flat sides of the cutter blades face to face in a straight line perpendicular to the material being cut.

The clamping assemblies 31 and 32 are then moved in a direction perpendicular to the micro-extrusion until the blades 31d and 32d penetrate the top wall and bottom wall, respectively, of the micro-extrusion, the position illustrated in FIG. 4a. When the clamping assemblies 31 and 32 have reached the stop position, which is the exact tolerance of the finished tube height and is set by the depth to which the blades 31d and 32d are set, then the upper cutter blade 31d and the bottom cutter blade 32d have penetrated the top and bottom walls of the tube approximately 60% of the wall thickness respectively. Then the clamped blocks are moved laterally, with block 31b being moved to the right, as illustrated in FIG. 4b, and block 32a being moved towards the left, as illustrated in FIG. 4b. Depending on the wall thicknesses involved and the port wall thickness, the lateral movement is less than 0.25 inches. During this lateral movement, the remaining metal fails by exceeding its yield point, which is 20-40% in the case of aluminum.

Due to the pull apart feature and the elongation characteristics of the aluminum, the metal in the remaining wall and port webs tends to neck down into a bell mouth shape, as illustrated in FIGS. 5a and 5b which is favorable from a flow entering and leaving standpoint. In use, a plurality of the micro-tubes 10 are inserted into headers or manifolds (not shown) in forming a finished condenser product. The bell mouth shape is very advantageous to flow of liquid or gases from a manifold into or out of the tubing with minimal pressure drop. In all cases, the integrity of the inside

of the tube has been maintained. Also, the inside of the tube is devoid of contamination and the full opening is maintained without restriction to flow.

All elements including the webbing and the side portions, even though not cut by the severing tool, are torn apart with the axial drawing of the element. The inner channel is not breached by any cutting tool, lubricants or scraps or cuttings in this method to provide micro-tubes of a predetermined length that are completely devoid of contamination therein.

Referring now to FIG. 6-6c, in accordance with another method for separating the micro-extrusion into a plurality of sections to provide micro-tubes 10, the continuous micro-extrusion may be scored on both the upper wall 13 and the lower wall 14 using a suitable scoring apparatus 41 to provide a cut or slot 42 in the upper and lower walls, as shown in FIG. 6. In the alternative, the continuous micro-extrusion may be cut on both the upper wall 13 and the lower wall 14 utilizing a knife or blade means 434 to provide a cut or slot 42 in the upper and lower walls, as shown in FIG. 6a. It is generally preferred that the scoring or cutting penetrate approximately 75% through the upper and lower walls to provide the slot or groove 42. However, it is important that the scoring or cutting of the upper and lower walls does not extend or penetrate through the wall thickness or the integrity of the inside of the tube will become contaminated.

Then, a high pressure air source 46 (FIG. 6b) is used to remove the metal slivers, particles or other contaminants which may be contained in the slots or grooves 42. A pair of clamping blocks 31a and 32a are clamped or applied to the upper and lower walls, respectively, with the ends of the blocks 31c and 32c positioned adjacent the grooves 42. Thereafter, the free end portion of the micro-tube 10 is moved upwardly and downwardly in an increasing amplitude until the micro-tube is severed by this worrying action. As indicated previously, because of the pull-apart properties and the elongation characteristics, the junction or ends of the separation will be necked down into a bell shape, as illustrated in FIG. 5b. Also, the inside of the micro-tube 10 will be free of contamination and the entire opening is maintained without restriction to flow.

In each of the above-described methods for separating micro-extrusions into sections of micro-tube, the ports or inner channels are not breached during the separation process and no chips, slivers or other contamination or foreign materials are allowed to enter into the ports or channels during the process. Also, the processes do not restrict the channels or openings during the separation, the channels being maintained to their full opening without restriction to flow in use. The inner channels are not breached by the cutting tool, any lubricants or scraps or cuttings.

Claims

1. A method of separating a metallic thin-walled, multiport tubing into sections (10) suitable for use as pass portions in a heat exchanger assembly, characterised in that the method comprises the steps of:

   providing a groove (42) in an upper wall (13) of the tubing to a depth less than the thickness of the upper wall,

   providing a groove (42) in a lower wall (14) of the tubing to a depth less than the thickness of the lower wall of the tubing, the grooves in the upper and lower walls being aligned and extending transversely of the tubing defining first and second tubing portions, and

   moving the first tubing portion relative to the second tubing portion with sufficient force to exceed the yield point of the metal to thereby sever the first tubing portion from the second tubing portion.

2. A method according to claim 1, characterised in that the first tubing portion is drawn away from the second tubing portion in a direction substantially perpendicular to the grooves.

3. A method according to claim 2 characterised in that the step of drawing the first and second tubing portions apart includes applying a first clamping means (31a, 32a) to the upper and lower walls of the first tubing section and applying a second clamping means (31b, 32b) to the upper and lower walls of the second tubing section, rigidly clamping the first clamping means to the first tubing section and rigidly clamping the second clamping means to the second tubing section and moving the first and second clamping means in opposite directions carrying with them the first and second tubing sections clamped thereto.

4. A method according to any one of claims 1 to 3, characterised in that providing the grooves includes scoring the surfaces of the upper and lower walls of the tubing.

5. A method according to any one of claims 1 to 3, characterised in that providing the grooves includes cutting grooves in the upper and lower walls of the tubing.

6. A method according to claim 5, characterised in that the grooves are cut to a depth of approximately 75% to 95% of the thickness of the upper and lower walls.

7. A method according to claim 2 or 3, characterised in that providing the grooves includes extending

first (31c) and second (32c) cutting blades perpendicular to the upper and lower surfaces, respectively, of the tubing, and causing the cutting blades to penetrate the surface of the upper and lower walls to a depth of approximately 60%.

8. A method according to claim 7, characterised in that drawing the first and second tubing portions apart includes using the cutting blades to push the tubing portions in opposite directions.

9. A method according to claim 6, 7 or 8, characterised in that the cutting edges of the blades are aligned along an axis generally perpendicular to the upper and lower walls of the tubing.

10. A method according to any one of claim 7 to 9, characterised in that the amount of extension of the cutting blade relative to the clamping means is preset to thereby preset the depth of penetration of the blade into the upper and lower walls of the tubing.

11. A method according to claim 1, characterised by applying a clamping means (31a, 32a) to the upper and lower walls of the first tubing portion adjacent the groove, and reciprocating the second tubing portion in a back and forth motion with sufficient force relative to the clamped first portion to exceed the yield point of the metal to thereby sever the first tubing portion from the second tubing portion.

12. Apparatus for use in separating a thin-walled multiport extrusion into a plurality of sections (10) of micro-tube for use in a heat exchanger, characterised in that said apparatus comprises first clamping means (31), second clamping means (32), first cutting means (31c) carried by said first clamping means, second cutting means (32c) carried by said second clamping means, said first clamping means being positionable on an upper wall (13) of said extrusion with the cutting means penetrating the upper wall to a preselected depth, and said second clamping means being positionable on a lower wall (14) of said extrusion with said second cutting means penetrating the lower wall a predetermined depth, and means for producing relative movement between said first clamping means and said second clamping means in opposite directions whereby said first cutting means and second cutting means move the first and second tubular sections in opposite directions, severing at the point of contact of said first and second cutting means with said extrusion.

13. Apparatus according to claim 12, characterised in that each of said cutting means comprises a cutting blade having a tapered edge (31d, 32d) terminating at a point, and a straight edge, the straight edges of the first and second cutting means being aligned along an axis perpendicular through the material being separated and oriented with their straight edges extending in opposite directions whereby the first and second cutting blades engage the material on opposite sides of the axis.

14. Apparatus according to claim 13, characterised in that the angle of said cutting blades is approximately 45%.

15. Apparatus according to claim 13 or 14, characterised in that each of said clamping means (31, 32) comprises a pair (31a-31b, 32a-32b) of clamping blocks, each of said cutting blades being associated with one of said pairs of clamping blocks and being carried by one of the clamping blocks of the associated pair.

FIG. 1

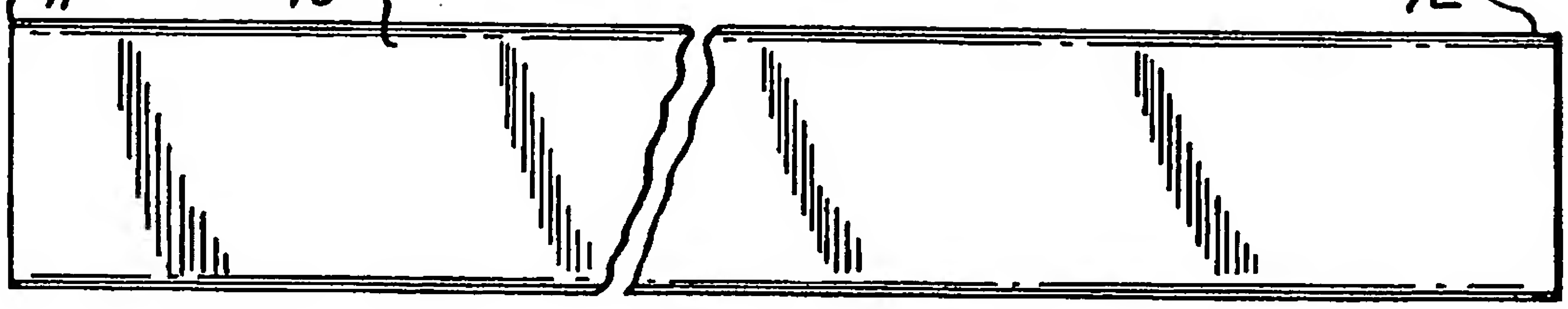


FIG. 2

FIG. 3

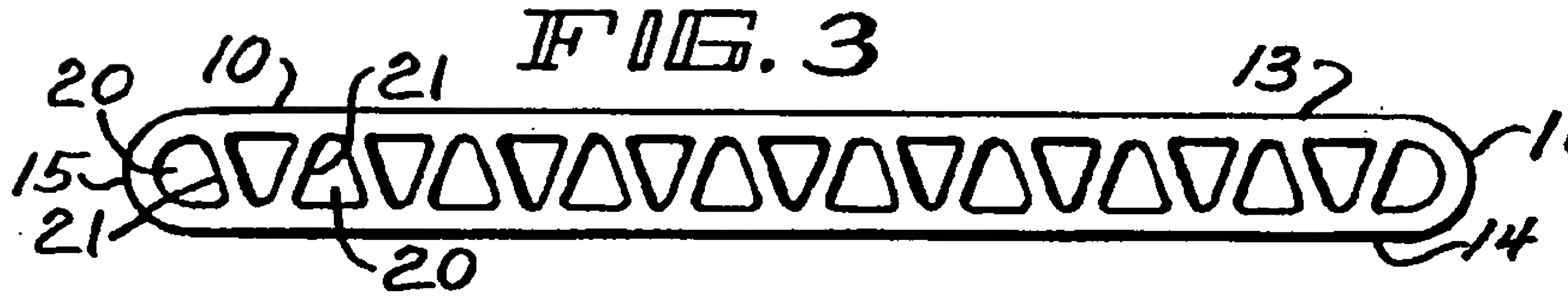


FIG 4a

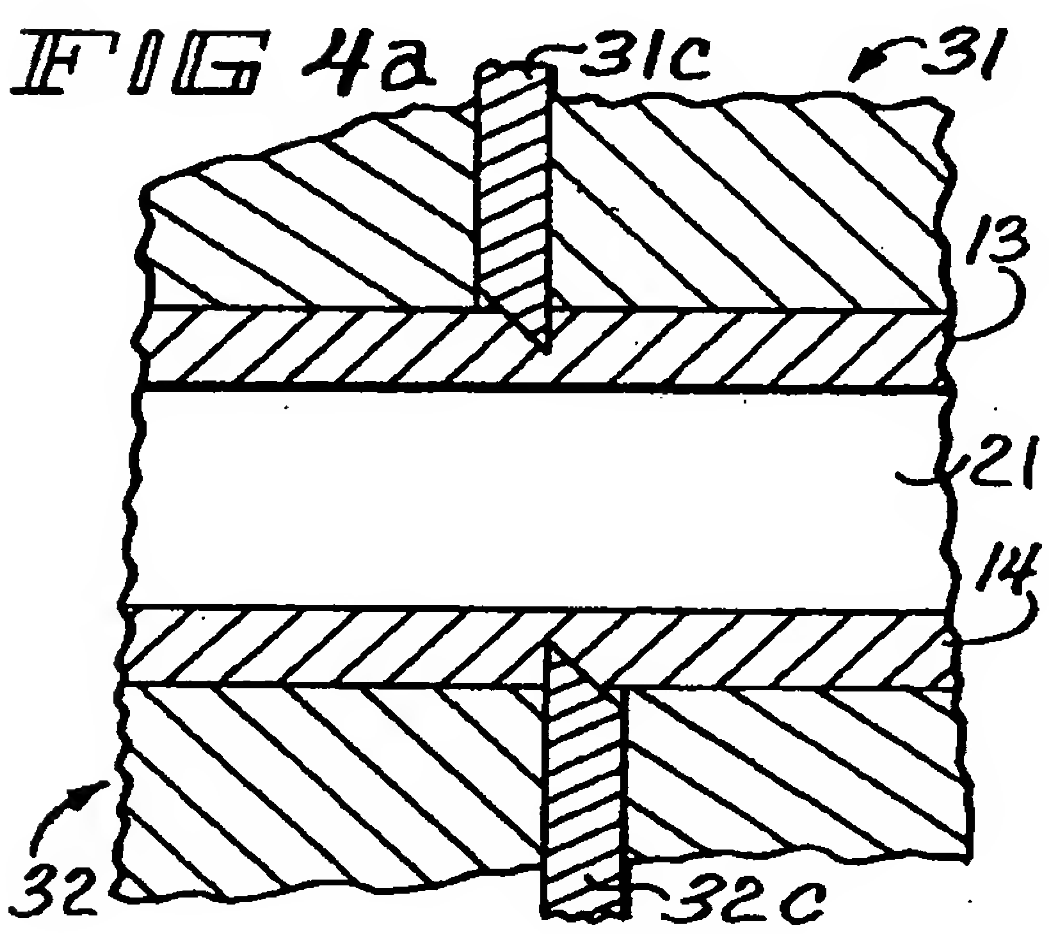
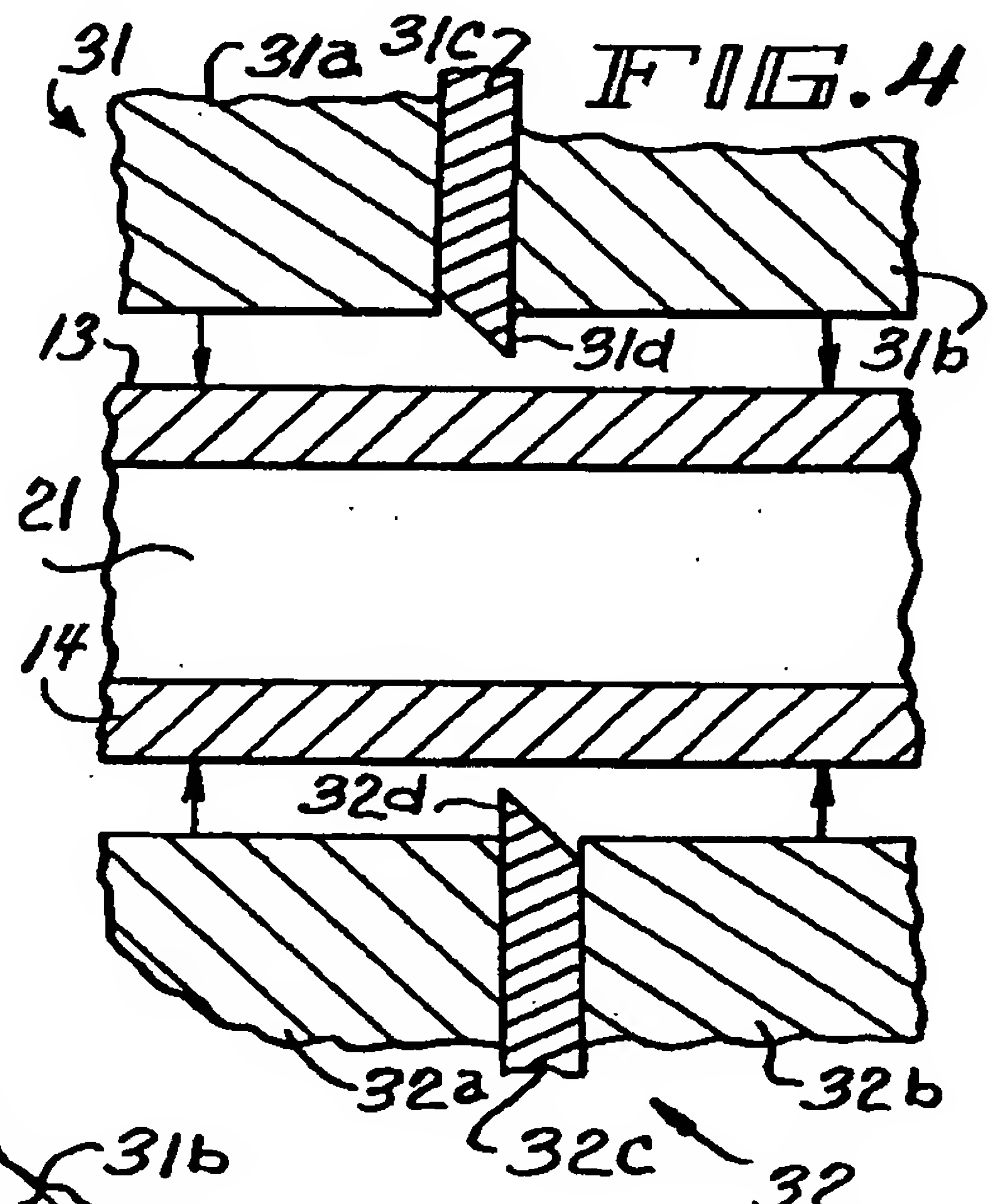


FIG. 4



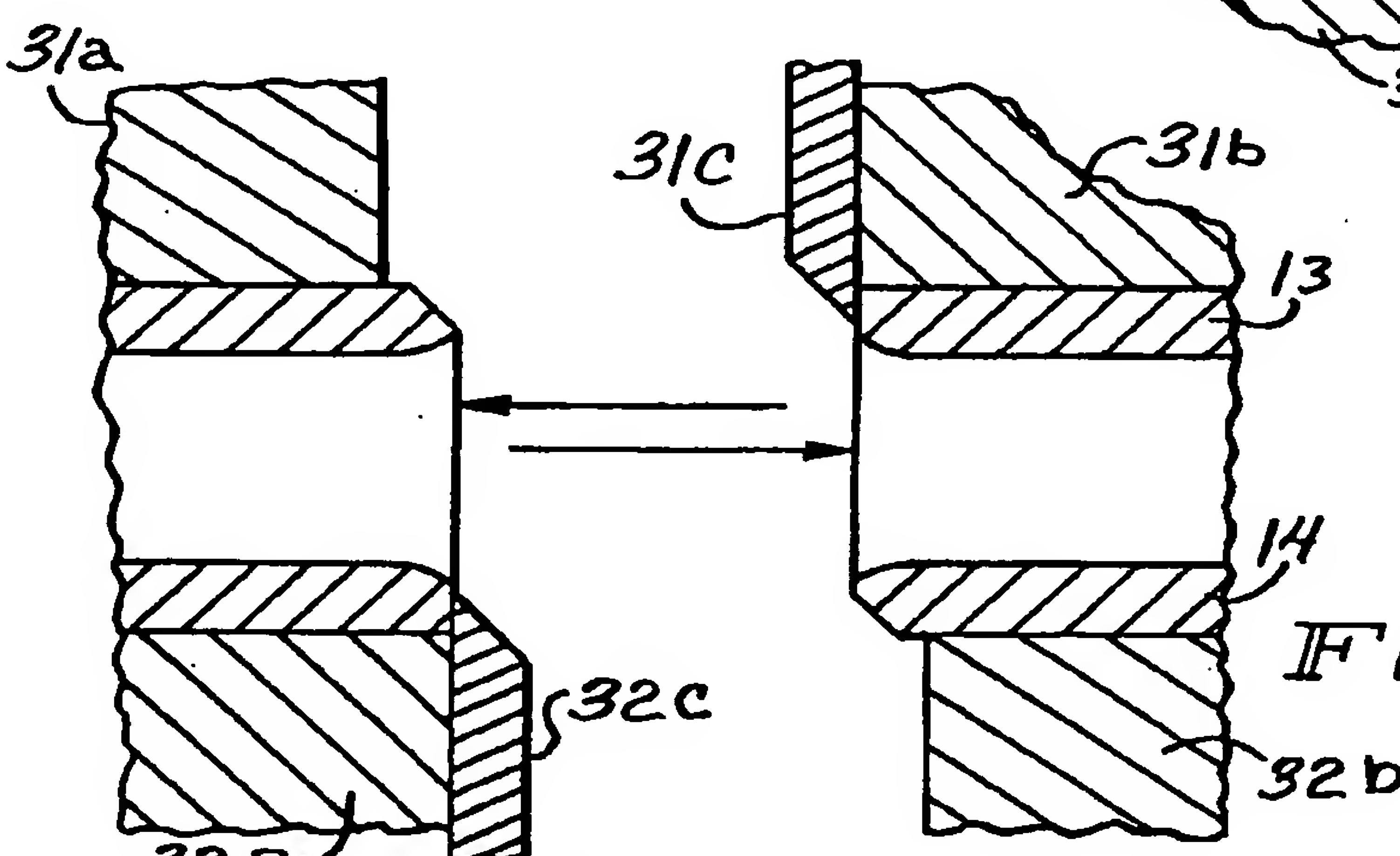


FIG. 4b

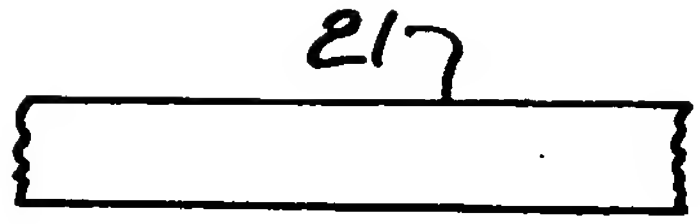


FIG.5

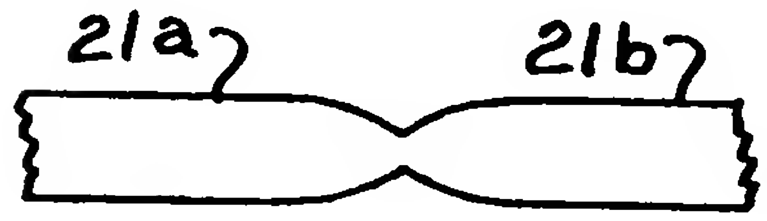


FIG. 5a

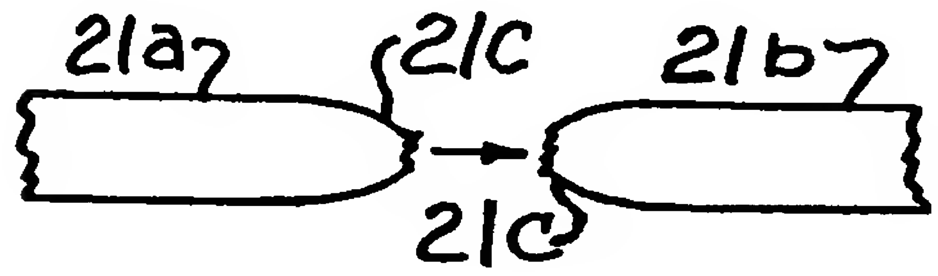


FIG.5b

FIG.6

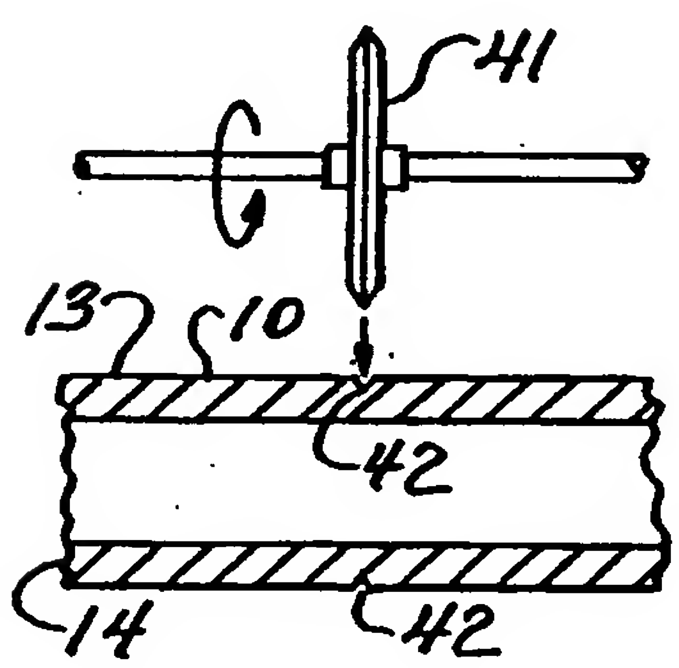


FIG. 6a

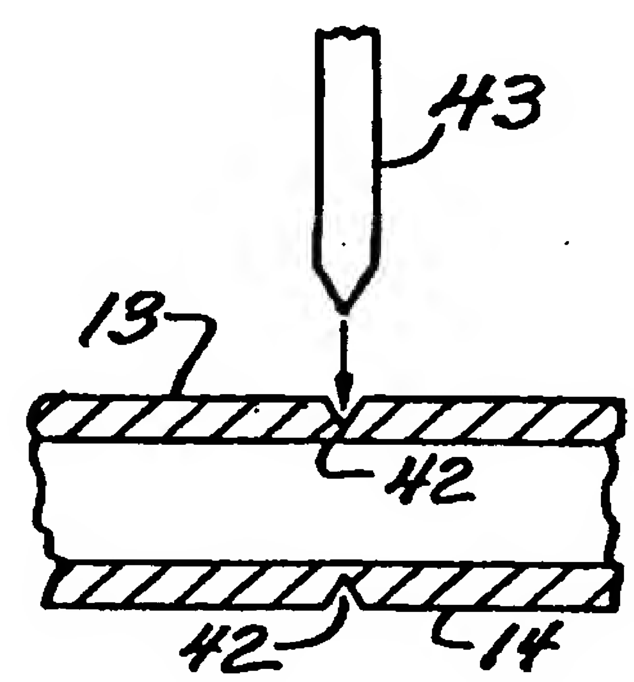


FIG.6b

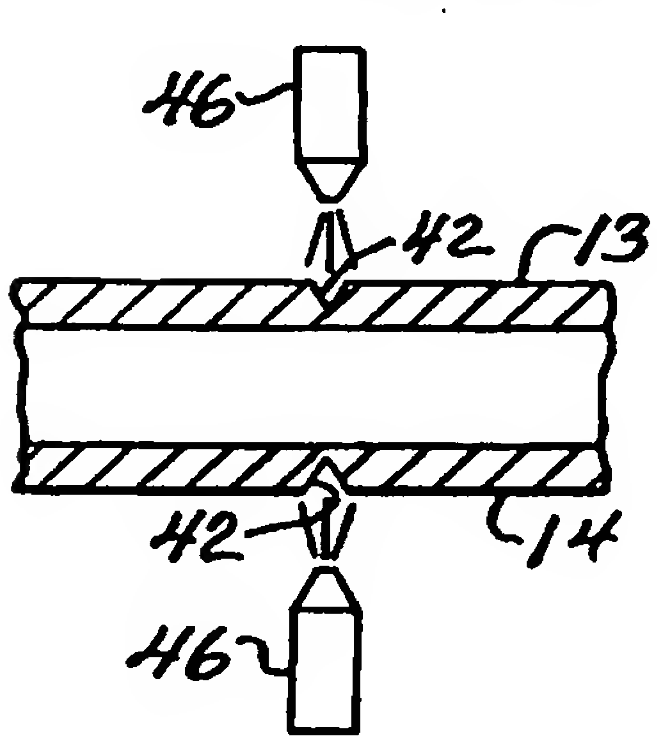
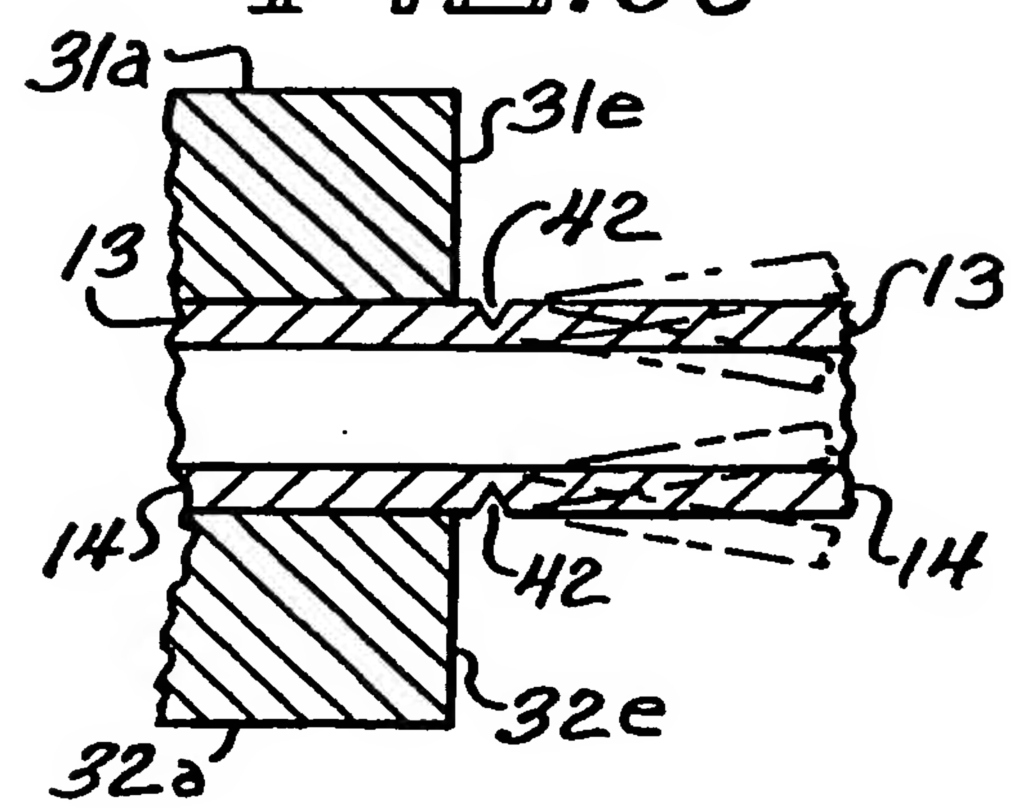


FIG.6c



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EUROPEAN SEARCH REPORT

Application Number

EP 91 31 1826

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	GB-A-1 600 926 (BERTOLETTE MACHINES INC.) * page 1, line 35 - page 2, line 19 * * page 7, line 15 - line 18; figures 1,6-8 *	1,5,6,11	B23D31/00 B26F3/00
Y		2-4,12	
Y	US-A-3 747 456 (KOCHINASHVILI ET AL) * column 2, line 51 - column 3, line 2; figure 8 *	2,3,12	
Y	US-A-4 552 291 (SCHOTT) * column 3, line 43 - line 49 *	4	
A		15	
A	FR-A-2 288 582 (AUTOMOTIVE PRODUCTS LIMITED) * page 3, line 1 - line 12; figure *	7-10,13,14	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B23D
B26F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 MARCH 1992	GARELLA M.G.C.D.

CATEGORY OF CITED DOCUMENTS

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